

October 1993

Preliminary Data Summary

by Field Research Facility

**U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
1261 Duck Road
Duck, NC 27949-4472**

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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Table 2 and Figure 3 identifies the location of the instruments. Figure 2 shows weather and ocean conditions for the month. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

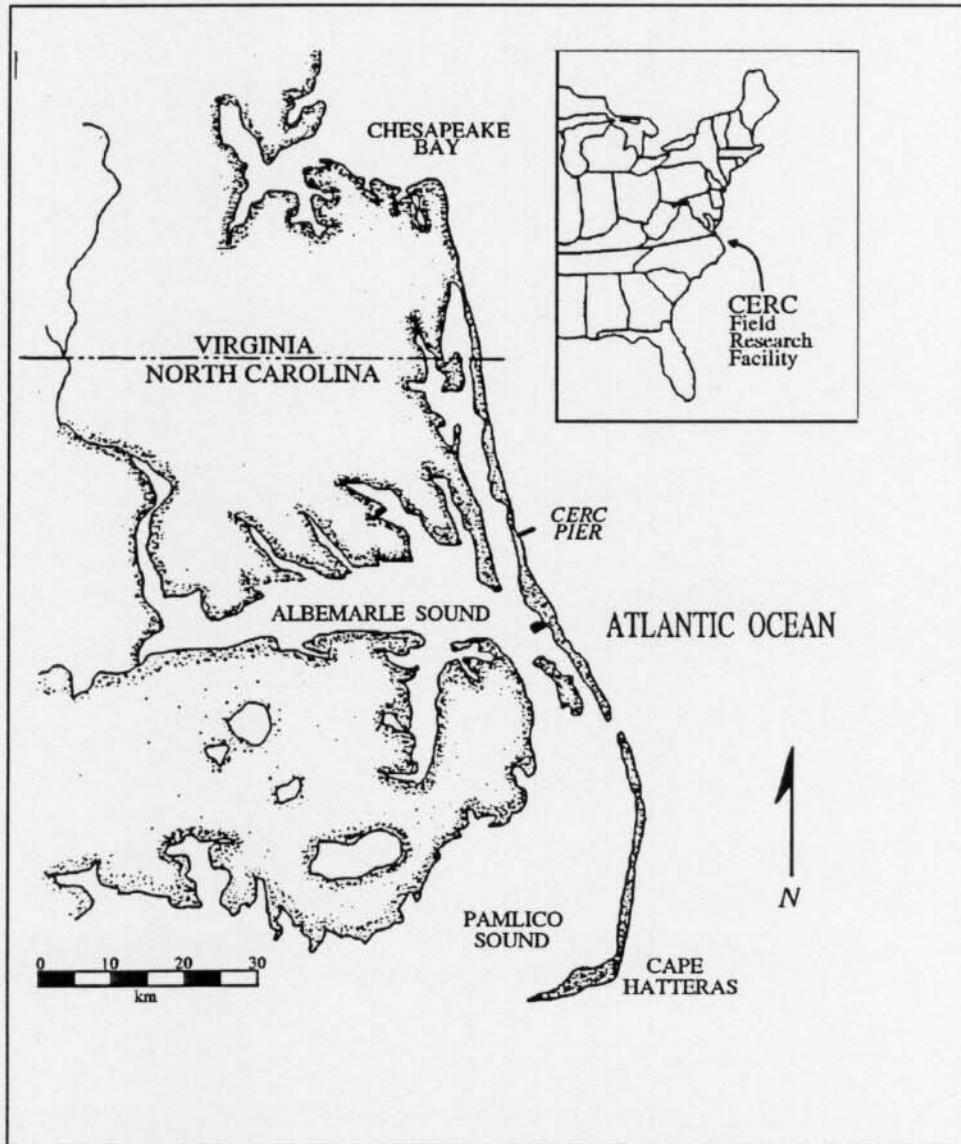


Figure 1. FRF Location Map

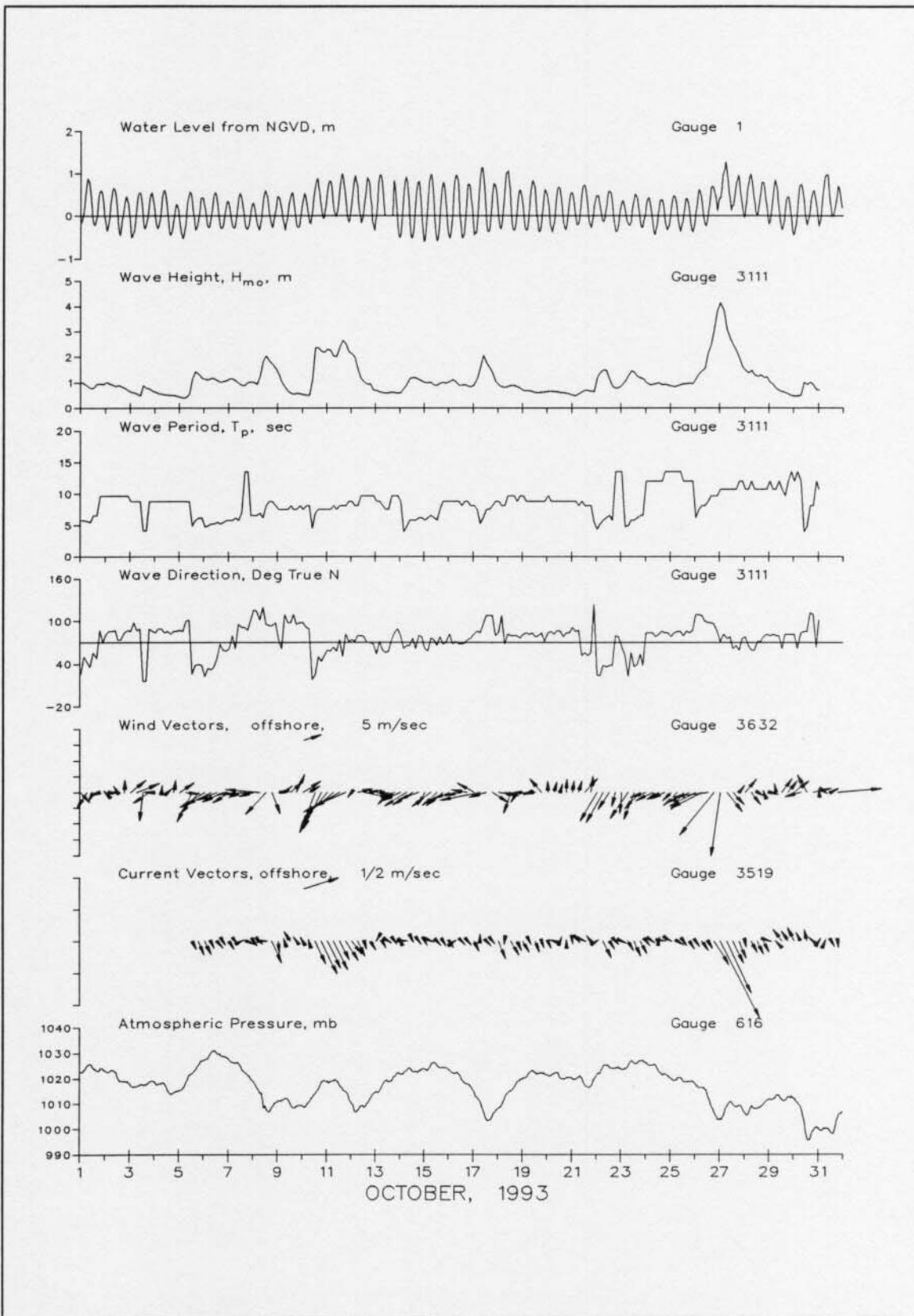


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		October 1993																																		
Gauge ID	Description/Remarks	Day of the month																																		
		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1				
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
632	Anemometer on top of building	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
932	Anemometer at seaward end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
641	Pressure Gauge at station 780 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff at station 1860 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
511	Pressure Gauge 434 m north of FRF pier (0.9 km offshore)	Gauge Status	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
519	Current meter 434 m north of FRF pier (0.9 km offshore)	Gauge Status	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
1	NOAA tide station at seaward end of FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Gauge Status * = Operational / = Partial - = Non-Operational
 Data Collected * = All / = Partial - = None
 Visual Observations * = Complete / = Partial - = None

Table 2
Gauge Locations

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates X, m Y, m		Gauge Depth NGVD, m	Water Depth NGVD, m
616	Barometer	36 10' 45.48"	75 44' 37.39"	11.60	569.00	-----	-----
632	Building Anemometer	36 10' 45.24"	75 44' 39.53"	21.45	515.83	19.94	-----
932	EOP Anemometer	36 11' 2.64"	75 44' 46.50"	585.20	517.30	19.50	-----
641	780 Pressure	36 10' 51.96"	75 44' 42.21"	239.11	516.64	-1.64	-1.96
625	1860 Baylor	36 11' 2.10"	75 44' 46.31"	568.00	516.64	Surface	-8.36
3111	8m Array	36 11' 15.90"	75 44' 38.88"	914.43	825.52	-7.76	-8.08
511	Pressure N Tripod	36 11' 17.17"	75 44' 34.15"	914.76	950.00	-6.70	-7.90
630	Waverider	36 12' 16.44"	75 47' 19.23"	3934.96	-2400.81	Surface	-17.00
519	Current N tripod	36 11' 17.17"	75 44' 34.15"	914.76	950.00	-5.30	-7.90
1	NOAA Tide	36 11' 2.95"	75 44' 46.76	596.49	514.2	Surface	-7.62

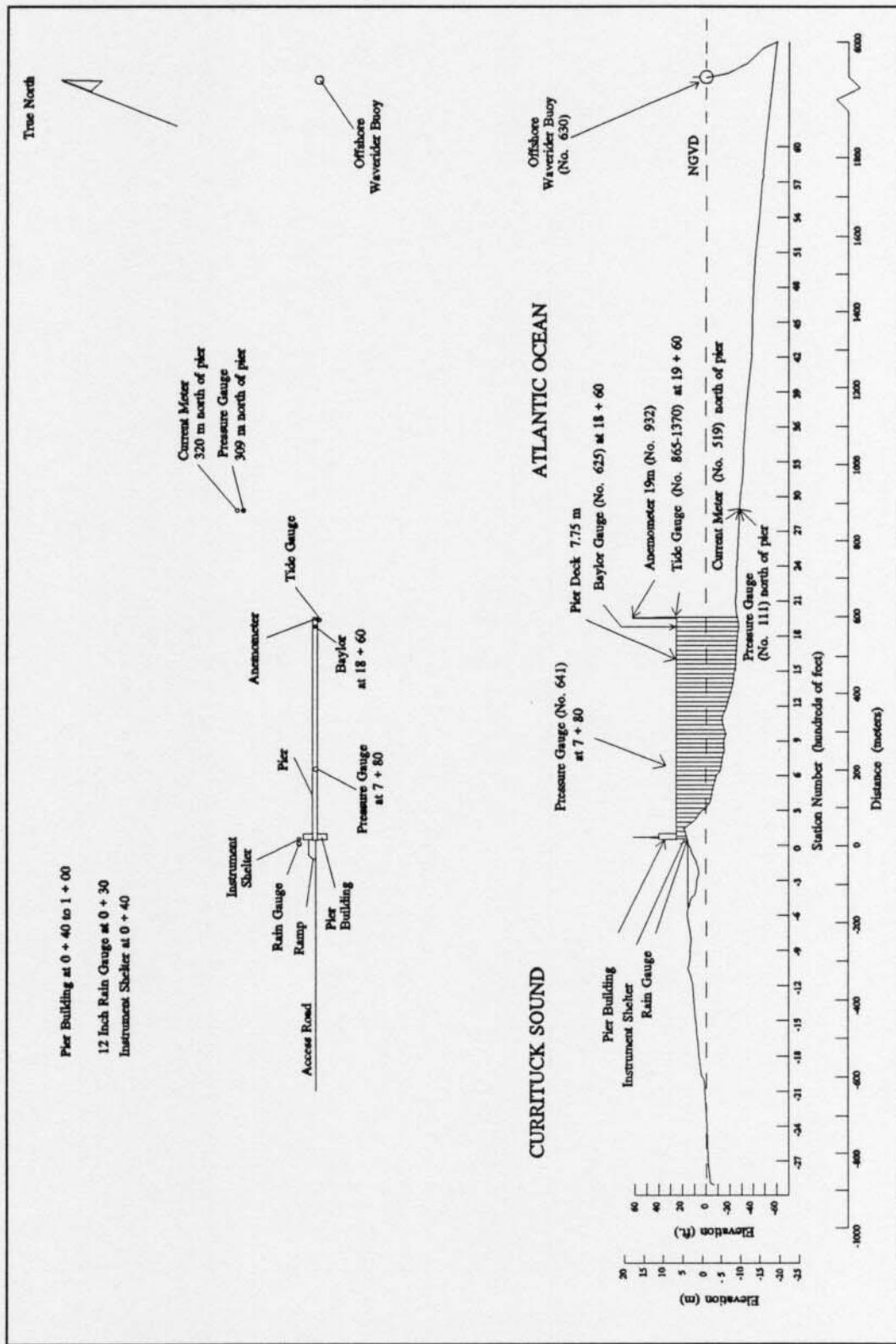


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 4) using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

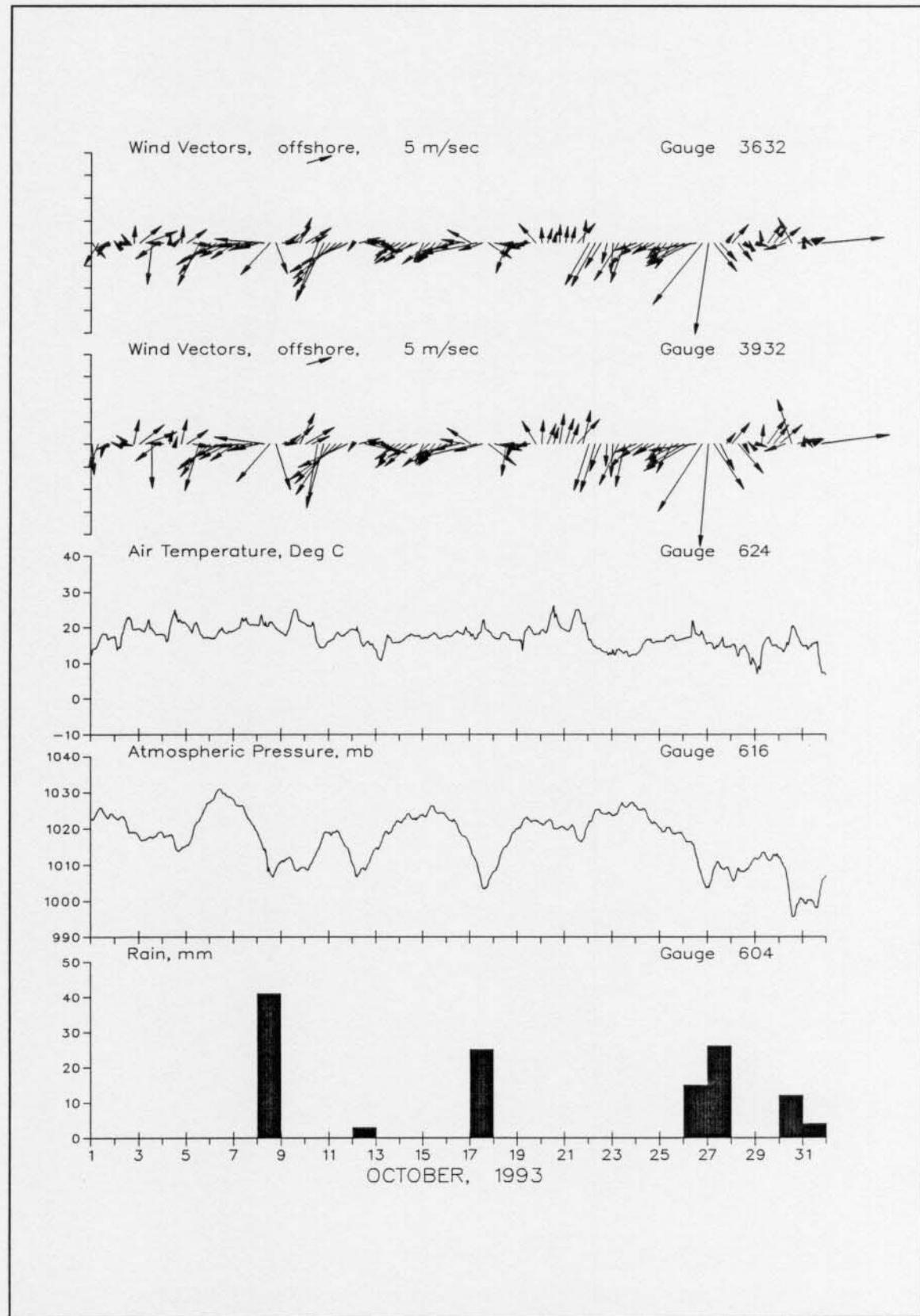


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

October 1993						
		Wind Speed	Wind Direction	Temperature deg C	Atm Pressure mb	Precipitation mm
Day	Hour	m/sec	deg TN			
1	100	7	356	12.3	1022.8	0
	700	5	19	15.2	1024.9	0
	1300	3	11	18.3	1024.4	0
	1900	3	66	17.0	1023.4	0
2	100	1	118	16.3	1023.1	0
	700	2	278	17.2	1023.4	0
	1300	3	132	23.0	1020.4	0
	1900	5	190	19.4	1019.0	0
3	100	6	227	19.7	1017.7	0
	700	6	1	19.8	1016.9	0
	1300	10	359	19.8	1017.6	0
	1900	6	48	18.0	1018.6	0
4	100	3	93	17.9	1018.5	0
	700	3	191	19.3	1018.1	0
	1300	2	193	25.1	1015.6	0
	1900	6	190	22.0	1014.4	0
5	100	5	231	20.8	1015.5	0
	700	4	279	19.3	1018.5	0
	1300	11	14	19.8	1022.0	0
	1900	9	32	17.2	1025.3	0
6	100	8	48	17.1	1027.5	0
	700	8	55	17.6	1030.0	0
	1300	6	62	20.0	1030.2	0
	1900	7	59	18.6	1028.7	0
7	100	6	51	19.2	1027.6	0
	700	5	85	20.4	1026.2	0
	1300	4	66	22.9	1023.9	0
	1900	6	86	20.8	1021.3	0
8	100	5	74	20.6	1018.6	0
	700	10	99	20.7	1014.2	15
	1300	10	37	21.5	1008.4	26
	1900	10	345	19.8	1008.7	0
9	100	3	266	18.6	1011.3	0
	700	3	229	19.0	1012.0	0
	1300	6	223	24.8	1009.8	0
	1900	7	202	22.0	1009.1	0
10	100	7	235	21.0	1009.0	0
	700	4	240	20.5	1010.6	0
	1300	14	8	15.8	1014.1	0
	1900	13	13	14.4	1018.4	0

Table 3
Meteorological Data (continued)

October 1993						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	13	29	16.2	1019.0	0
	700	12	41	17.9	1019.1	0
	1300	13	51	17.7	1017.3	0
	1900	11	61	18.7	1014.8	0
12	100	2	31	19.5	1009.9	0
	700	4	253	18.7	1007.6	3
	1300	8	283	15.2	1008.6	0
	1900	2	257	15.1	1012.1	0
13	100	5	292	13.2	1014.9	0
	700	2	293	12.0	1017.4	0
	1300	5	22	17.8	1018.6	0
	1900	4	45	15.7	1020.8	0
14	100	6	54	16.0	1021.8	0
	700	8	48	17.2	1023.1	0
	1300	7	47	18.0	1022.7	0
	1900	6	63	17.6	1023.0	0
15	100	5	21	17.1	1023.8	0
	700	7	45	17.6	1025.3	0
	1300	6	38	18.2	1025.0	0
	1900	7	41	17.0	1024.2	0
16	100	8	59	17.8	1023.2	0
	700	7	71	17.9	1022.1	0
	1300	5	74	18.7	1019.6	0
	1900	5	102	19.3	1017.8	0
17	100	6	127	18.2	1014.8	4
	700	12	74	17.0	1010.8	21
	1300	6	73	20.7	1004.0	0
	1900	7	311	19.3	1005.4	0
18	100	5	285	17.4	1008.3	0
	700	4	288	17.3	1012.3	0
	1300	7	7	18.4	1015.1	0
	1900	4	19	16.6	1018.6	0
19	100	3	87	16.5	1019.9	0
	700	2	59	17.0	1022.4	0
	1300	3	81	20.1	1022.1	0
	1900	6	152	18.1	1022.4	0
20	100	5	182	19.4	1021.4	0
	700	5	199	19.5	1022.0	0
	1300	4	193	26.1	1020.1	0
	1900	7	187	20.8	1020.4	0

Table 3
Meteorological Data (concluded)

October 1993						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	6	195	19.4	1019.9	0
	700	5	198	20.1	1020.6	0
	1300	7	217	25.0	1017.4	0
	1900	8	191	21.2	1017.0	0
22	100	11	15	16.6	1021.6	0
	700	11	14	14.8	1024.9	0
	1300	6	20	13.8	1024.6	0
	1900	5	2	13.2	1023.9	0
23	100	7	2	13.8	1023.6	0
	700	10	21	13.9	1024.9	0
	1300	10	10	12.9	1026.1	0
	1900	7	35	12.1	1026.9	0
24	100	5	65	12.5	1026.2	0
	700	5	55	14.8	1025.2	0
	1300	4	49	17.0	1023.0	0
	1900	4	57	15.8	1021.8	0
25	100	4	36	16.3	1020.2	0
	700	6	37	17.1	1019.9	0
	1300	7	25	17.8	1018.9	0
	1900	7	59	16.6	1018.9	0
26	100	9	54	17.0	1017.5	0
	700	11	55	17.4	1016.4	0
	1300	9	81	18.2	1012.7	6
	1900	17	29	18.6	1006.7	9
27	100	23	3	15.9	1004.2	26
	700	11	330	14.0	1008.9	0
	1300	6	336	15.8	1009.8	0
	1900	3	216	14.5	1009.3	0
28	100	6	215	15.1	1006.3	0
	700	8	323	12.0	1009.1	0
	1300	2	335	15.0	1008.2	0
	1900	1	140	10.7	1009.8	0
29	100	2	288	9.4	1011.9	0
	700	4	184	12.4	1013.1	0
	1300	6	211	17.3	1011.7	0
	1900	5	213	14.8	1012.9	0
30	100	6	224	14.3	1012.0	0
	700	4	68	14.3	1008.9	0
	1300	10	164	19.9	996.7	12
	1900	5	254	17.7	999.3	0
31	100	2	184	14.8	1000.3	0
	700	1	321	14.6	1000.1	4
	1300	2	1	15.6	998.2	0
	1900	13	260	8.0	1004.4	0
		Resultant		Mean	Mean	Total
		3	35	17.5	1017.0	126

3 Wave Data

Wave data are collected from a Baylor staff gauge (Gauge 625), two pressure wave gauges (641 and 511) and a Waverider buoy (Gauge 630) as shown in Table 1 and Figure 3. The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 11/750 programmed to sample the gauges for two hour and forty-eight minute time frames. The sampling rate is two times per second which equals five contiguous 34 minute records per collection period. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to optical disc.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

October 1993									
Day	Hour	641 Pressure Gauge		625 Baylor 1860		511 Pressure Gauge		630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec
1	0100	0.52	5.33	0.96	5.69	Gauge		1.16	5.57
	0700	0.51	5.57	0.91	5.82			1.19	5.69
	1300	0.28	9.48	0.78	6.56			0.85	6.56
	1900	0.36	9.85	0.89	9.85			1.07	9.48
	0100	0.28	9.85	0.87	9.85			1.02	10.24
2	0700	0.33	9.48	0.82	9.48	Inoperative		0.88	9.48
	1300	0.22	9.48	0.76	9.48			0.87	9.14
	1900	0.26	9.14	0.71	9.48			0.81	9.85
	0100	0.20	9.48	0.65	9.48			0.67	9.14
3	0700	0.25	8.53	0.53	8.83	Inoperative		0.61	8.53
	1300	0.51	4.00	0.83	3.94			0.94	3.82
	1900	0.43	4.57	0.72	4.49			0.83	4.41
	0100	0.26	3.56	0.61	9.14			0.67	8.26
4	0700	0.25	9.14	0.52	9.14	Inoperative		0.59	9.14
	1300	0.19	8.83	0.54	8.83			0.52	9.14
	1900	0.22	8.26	0.51	8.83			0.56	8.53
	0100	0.16	9.14	0.44	9.14			0.48	9.14
5	0700	0.18	8.83	0.41	8.83	0.41	8.83	0.42	8.83
	1300	0.62	4.41	0.93	4.27	0.90	3.88	1.06	4.34
	1900	0.67	5.95	1.31	6.09	1.31	6.24	1.50	6.09
	0100	0.52	4.13	1.07	4.34	1.12	4.83	1.24	5.95
6	0700	0.52	4.57	1.11	4.74	1.10	4.66	1.28	5.22
	1300	0.46	4.41	1.03	5.12	1.06	5.22	1.14	5.33
	1900	0.43	3.28	0.99	5.33	0.95	5.57	1.11	5.12
	0100	0.49	5.22	1.11	5.69	1.09	5.02	1.27	5.57
7	0700	0.52	5.02	1.05	5.57	1.04	6.40	1.16	5.57
	1300	0.53	4.74	0.87	8.00	0.89	5.57	0.99	5.69
	1900	0.53	5.12	0.98	6.24	0.91	14.22	1.07	6.24
	0100	0.65	5.12	0.92	6.40	1.01	14.22	1.12	6.40
8	0700	0.77	5.57	1.21	6.92	1.15	6.24	1.33	6.40
	1300	1.43	7.76	1.91	8.00	2.04	8.26	2.36	8.00
	1900	0.93	8.83	1.69	8.83	1.86	8.83	1.98	8.53
	0100	0.61	7.76	1.41	7.53	1.35	7.76	1.62	7.53
9	0700	0.33	7.53	0.86	8.00	0.84	8.53	0.94	7.11
	1300	0.30	7.31	0.54	7.11	0.57	6.56	0.60	7.31
	1900	0.29	4.20	0.57	7.76	0.55	8.00	0.73	7.76
	0100	0.31	7.31	0.46	8.53	0.51	7.53	0.63	7.76
10	0700	0.22	8.00	0.51	8.26	0.49	8.26	0.58	8.26
	1300	1.39	6.09	1.99	6.09	2.05	6.09	2.22	6.40
	1900	1.00	7.31	2.07	7.31	2.17	7.31	2.49	7.11

Table 4
Wave Data (continued)

October 1993									
Day	Hour	641		625		511		630	
		Pressure Gauge	Baylor 1860	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec
11	0100	1.18	6.74	2.00	7.31	2.17	7.31	2.56	7.53
	0700	0.92	7.53	2.04	8.00	2.02	8.26	2.30	7.76
	1300	1.10	6.74	2.09	8.83	2.17	8.53	2.47	8.00
	1900	1.07	8.26	2.30	11.13	2.51	8.83	2.77	8.83
12	0100	1.00	7.53	1.90	7.76	2.00	7.31	2.03	8.53
	0700	0.65	8.53	1.48	8.53	1.63	8.83	1.74	8.53
	1300	0.34	7.53	0.99	7.76	1.06	9.48	1.19	8.00
	1900	0.30	6.09	0.69	9.48	0.80	10.24	0.87	7.53
13	0100	0.22	14.22	0.63	8.83	0.72	8.00	0.75	8.83
	0700	0.24	8.53	0.53	8.26	0.59	8.83	0.62	8.26
	1300	0.21	11.13	0.58	7.31	0.56	7.53	0.63	7.53
	1900	0.30	4.34	0.56	8.83	0.55	8.00	0.60	8.26
14	0100	0.25	3.20	0.65	9.14	0.52	12.80	0.65	9.48
	0700	0.40	3.51	0.87	4.13	0.82	4.41	0.91	4.27
	1300	0.39	3.46	1.13	6.09	1.16	5.69	1.27	5.82
	1900	0.42	11.64	1.05	6.40	1.08	5.69	1.18	5.95
15	0100	0.30	3.24	0.91	5.82	1.00	9.85	1.06	5.69
	0700	0.41	3.16	1.06	6.09	0.95	6.56	1.12	6.56
	1300	0.28	2.61	0.83	10.67	0.82	8.00	0.93	5.69
	1900	0.40	3.41	0.95	5.82	0.98	5.69	1.04	5.33
16	0100	0.32	3.37	0.97	9.14	1.00	9.85	1.07	8.83
	0700	0.44	4.06	1.03	9.14	1.02	8.26	1.08	4.92
	1300	0.32	3.41	0.81	4.92	0.85	8.83	0.88	8.26
	1900	0.38	4.57	0.87	8.26	0.84	8.00	0.90	8.00
17	0100	0.32	4.74	0.86	8.00	0.87	8.26	0.95	8.00
	0700	0.79	4.57	1.26	4.57	1.28	4.83	1.39	5.12
	1300	0.99	7.11	1.70	6.92	1.73	6.92	2.02	6.74
	1900	0.81	7.53	1.28	8.00	1.33	7.53	1.58	8.00
18	0100	0.36	9.48	0.87	8.83	0.98	8.26	1.09	8.53
	0700	0.36	8.53	0.72	8.00	0.86	8.00	0.81	8.00
	1300	0.38	3.66	0.79	9.48	0.79	9.14	0.95	8.83
	1900	0.37	7.31	0.79	7.76	0.80	8.00	0.98	9.48
19	0100	0.25	7.31	0.64	9.48	0.65	7.76	0.70	8.83
	0700	0.25	9.14	0.64	9.14	0.63	9.48	0.73	9.14
	1300	0.23	6.24	0.58	9.48	0.58	9.48	0.68	8.26
	1900	0.26	5.95	0.65	8.53	0.61	8.83	0.70	9.14
20	0100	0.25	9.85	0.60	9.14	0.60	8.83	0.70	8.83
	0700	0.21	8.53	0.69	8.53	0.61	9.14	0.68	8.83
	1300	0.26	9.14	0.57	9.48	0.60	9.14	0.66	8.00
	1900	0.23	16.00	0.60	9.14	0.57	9.14	0.63	8.53

Table 4
Wave Data (concluded)

October 1993									
Day	Hour	641		625		511		630	
		Pressure	Gauge	Baylor	1860	Pressure	Gauge	Waverider	Hmo,m
21	0100	0.22	16.00	0.47	8.83	0.47	8.83	0.56	8.53
	0700	0.21	3.88	0.52	8.53	0.48	8.53	0.59	8.53
	1300	0.38	5.22	0.67	7.76	0.66	7.76	0.83	8.83
	1900	0.31	5.02	0.64	8.26	0.59	8.00	0.76	5.22
22	0100	0.62	3.66	0.96	3.61	0.85	3.46	1.06	3.77
	0700	0.79	5.22	1.44	5.82	1.48	5.95	1.71	5.69
	1300	0.67	5.02	1.16	6.74	1.11	6.24	1.33	6.40
	1900	0.28	4.06	0.76	5.33	0.77	5.69	0.83	5.57
23	0100	0.39	3.61	0.84	13.47	0.78	6.09	0.91	6.92
	0700	0.58	4.57	1.13	4.92	1.15	4.74	1.25	5.22
	1300	0.83	5.22	1.36	5.69	1.37	6.09	1.61	5.69
	1900	0.52	4.06	1.18	5.82	1.21	6.40	1.30	6.56
24	0100	0.47	4.34	1.02	12.19	1.02	12.19	1.13	6.56
	0700	0.35	14.22	0.91	12.80	0.89	12.19	1.00	12.80
	1300	0.44	14.22	0.97	14.22	0.91	12.19	1.00	12.19
	1900	0.38	14.22	0.95	14.22	0.90	11.64	0.95	15.06
25	0100	0.43	14.22	0.79	13.47	0.82	13.47	0.92	12.19
	0700	0.42	12.80	0.87	12.80	0.85	11.64	0.90	13.47
	1300	0.49	13.47	1.00	13.47	0.91	12.80	0.99	11.13
	1900	0.48	5.45	1.01	12.80	0.95	12.80	1.11	3.88
26	0100	0.55	6.24	1.06	5.12	0.98	7.53	1.19	5.22
	0700	0.77	5.95	1.33	6.24	1.34	7.76	1.50	7.53
	1300	1.23	8.53	1.93	8.53	1.98	8.26	2.23	8.53
	1900	1.45	9.48	2.51	9.48	2.75	9.48	2.85	9.85
27	0100	1.32	9.14	3.09	9.14	3.90	10.24	4.39	9.14
	0700	1.44	11.13	2.91	11.13	3.20	10.67	3.65	9.85
	1300	1.12	11.64	2.28	10.67	2.33	10.67	2.58	11.13
	1900	1.05	11.64	1.80	11.13	1.96	11.64	2.10	11.13
28	0100	0.62	12.19	1.45	11.64	1.40	11.13	1.57	11.64
	0700	0.83	11.64	1.37	11.13	1.33	10.24	1.52	11.13
	1300	0.47	11.13	1.16	10.67	1.20	11.13	1.30	11.13
	1900	0.46	10.67	1.03	11.64	1.11	11.13	1.24	10.67
29	0100	0.31	13.47	0.97	11.13	1.07	12.19	1.03	10.67
	0700	0.25	11.64	0.69	12.19	0.75	10.67	0.81	10.24
	1300	0.17	12.80	0.61	10.67	0.65	11.13	0.61	9.48
	1900	0.20	14.22	0.56	11.13	0.52	12.19	0.59	12.80
30	0100	0.12	12.80	0.46	12.19	0.41	11.64	0.44	12.80
	0700	0.19	12.80	0.43	12.80	0.45	12.80	0.47	12.19
	1300	0.49	4.41	1.03	4.34	0.92	4.57	1.13	4.41
	1900	0.58	8.26	0.89	8.26	0.94	9.48	1.06	7.76
31	0100	0.27	9.85	0.62	9.48	0.64	10.24	0.75	8.26
	0700	0.43	9.48	0.66	9.14	0.70	9.14	0.81	9.14
	1300	0.26	8.83	0.71	7.53	0.74	8.53	0.85	6.92
	1900	0.27	9.14	0.50	8.83	0.57	8.53	0.95	8.53
<hr/>		Mean	0.49	7.66	1.02	8.39	1.09	8.53	1.17
<hr/>		Std dev	0.31	3.30	0.52	2.41	0.60	2.40	0.64
<hr/>									

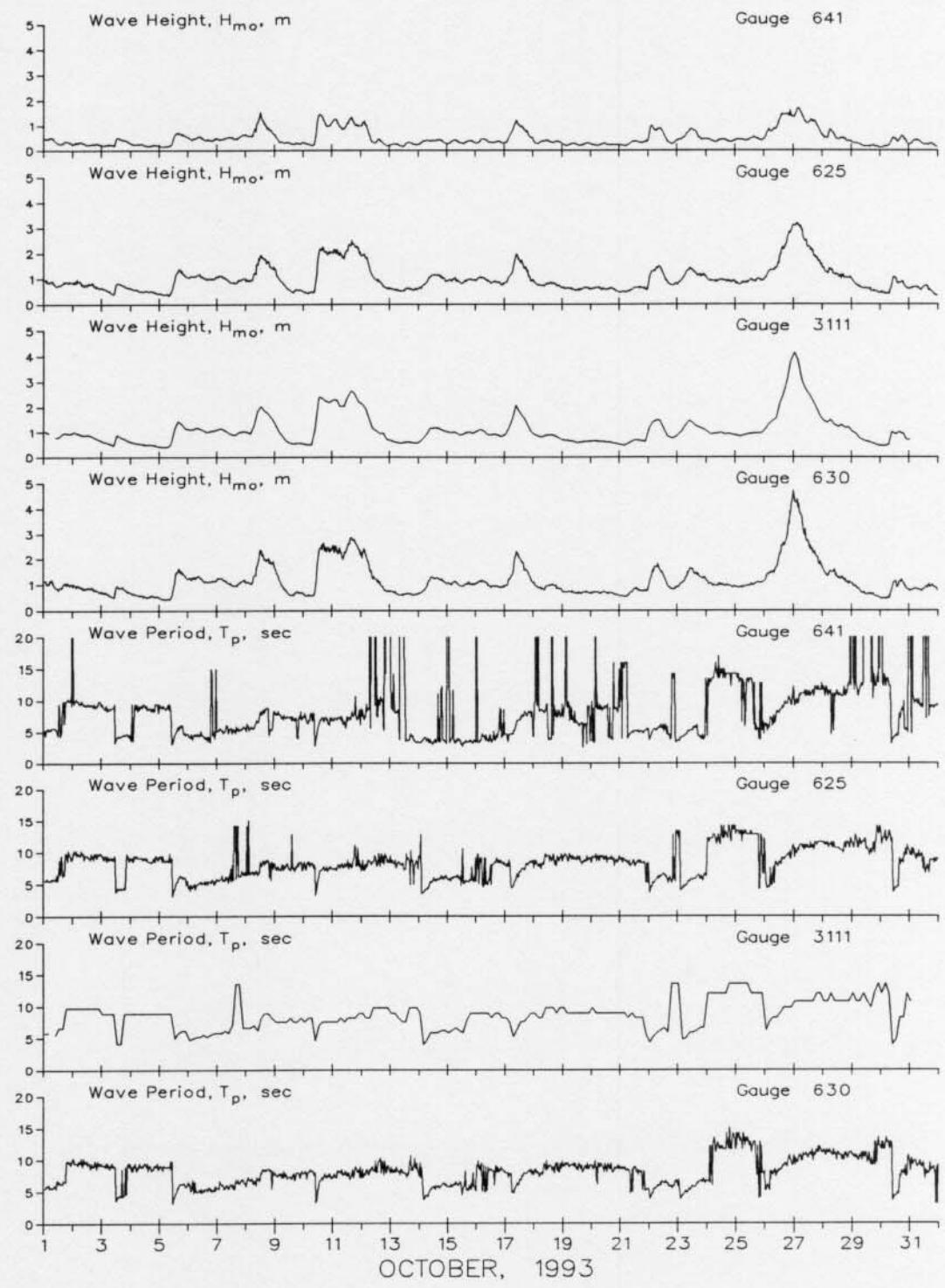


Figure 5. Time History of Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards.

Table 5
Current Meter Data - Gauge 519

October 1993

Cross Long				Cross Long				Cross Long								
Day	Time	Shore	Speed	Dir	Day	Time	Shore	Speed	Dir	Day	Time	Shore	Speed	Dir		
1	100				1300	7	32	33	156	22	100	3	-1	4	52	
	700				1900	10	34	35	152		700	5	28	29	158	
1300					12	100	9	23	25	148	1300	5	14	15	150	
1900					700	4	25	25	158		1900	4	7	7	140	
2	100	Gauge			1300	0	13	13	167	23	100	6	5	8	116	
	700				1900	5	16	16	151		700	5	17	17	152	
1300					13	100	0	1	1	208	1300	4	25	25	158	
1900					700	3	12	12	156		1900	5	22	23	155	
3	100				1300	4	4	5	127	24	100	4	8	9	144	
	700				1900	2	6	7	148		700	3	4	5	130	
1300		Inoperative			14	100	0	-6	7	341	1300	3	-6	7	10	
1900					700	1	0	1	95		1900	2	1	2	100	
4	100				1300	1	3	3	157	25	100	1	1	1	125	
	700				1900	2	6	6	148		700	8	8	11	124	
1300					15	100	2	8	8	156	1300	3	8	9	147	
1900					700	4	3	5	114		1900	4	14	15	152	
5	100				1300	4	8	9	142	26	100	3	10	10	149	
	700				1900	2	9	10	154		700	6	17	18	150	
1300	3	14	15	155	16	100	4	12	13	150	1300	3	13	13	154	
1900	4	23	23	159		700	1	0	2	51	1900	12	41	43	152	
6	100	5	22	23	156	1300	4	8	9	142	27	100	26	128	131	156
	700	3	12	12	156	1900	3	8	8	144		700	16	88	89	158
1300	6	12	14	142	17	100	4	17	17	155	1300	7	37	38	157	
1900	2	7	7	152		700	2	-9	11	1	1900	4	29	29	161	
7	100	4	14	15	152	1300	5	9	11	140	28	100	0	10	10	169
	700	3	7	7	147	1900	3	6	7	146		700	4	20	20	156
1300	5	-1	5	59	18	100	4	29	29	161	1300	4	22	23	158	
1900	9	7	11	118		700	-1	5	6	189	1900	4	19	19	157	
8	100	3	8	9	151	1300	6	24	25	154	29	100	2	1	2	110
	700	3	5	6	139	1900	3	16	16	157		700	0	0	0	
1300	2	1	2	92	19	100	4	19	19	155	1300	-6	-20	22	328	
1900	5	36	37	160		700	1	6	6	158	1900	-4	-16	18	331	
9	100	-1	18	18	174	1300	1	18	18	164	30	100	-4	-22	23	337
	700	0	-4	5	343	1900	1	11	11	164		700	-2	-14	15	337
1300	-5	-15	17	329	20	100	2	13	13	159	1300	1	-18	19	350	
1900	-2	-7	8	327		700	-5	-3	7	290	1900	-3	-6	8	316	
10	100	-1	-6	7	334	1300	3	-5	7	16	31	100	3	-3	5	29
	700	0	-2	3	347	1900	0	-2	3	356		700	1	-1	2	21
1300	7	38	39	158	21	100	0	5	5	172	1300	2	10	10	155	
1900	10	56	57	158		700	1	3	3	143	1900	0	10	10	173	
11	100	9	46	47	157	1300	2	1	2	117						
	700	9	49	50	157	1900	-3	-9	11	328	1900	0	10	10		

KEY:

- +crossshore = offshore, cm/sec
- crossshore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

October 1993												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	0	44	44	160	0	61	61	160	North	61	S	
2	0	5	5	160	0	-36	36	340	South	8	N	
3	-10	5	11	223	-11	6	13	221	North	15	S	
4	0	-41	41	340	0	-14	14	340	North	10	S	
5	10	-5	11	43	14	-23	27	11	South	12	N	
6	-24	14	28	220	0	30	30	160	South	15	S	
7	-9	-7	12	286	15	-44	46	359	South	4	N	
8	0	-12	12	340	0	-28	28	340	South	25	N	
9	18	-10	21	41	20	-8	22	47	South	13	N	
10	0	13	13	160	0	-16	16	340	South	0		
11	-46	76	89	191	0	122	122	160	North	15	S	
12	0	15	15	160	34	-14	36	48	South	23	S	
13	0	23	23	160	0	10	10	160	North	7	S	
14	-4	14	14	177	0	34	34	160	North	25	S	
15	0	14	14	160	0	38	38	160	North	17	S	
16	0	6	6	160	0	-34	34	340	South	15	N	
17	0	-30	30	340	0	-55	55	340	South	20	N	
18	0	15	15	160	0	9	9	160	North	23	S	
19	-37	8	37	250	0	-11	11	340	South	10	N	
20	0	-25	25	340	0	-51	51	340	South	23	N	
21	3	-5	6	11	0	-76	76	340	South	30	N	
22	0	44	44	160	0	87	87	160	North	30	S	
23	0	44	44	160	0	87	87	160	North	36	S	
24	-3	10	11	250	0	36	36	160	North	10	S	
25	0	14	14	160	0	-76	76	340	South	24	N	
26	-6	13	14	187	0	-30	30	340	North	15	N	
27	0	102	102	160	-91	51	105	221	North	61	S	
28	0	47	47	160	0	76	76	160	North	36	S	
29	0	-13	13	340	0	-22	22	340	South	15	N	
30	-10	-17	20	309	-4	-5	6	303	South	15	N	
31	0	-3	3	340	8	-16	18	7	South	5	N	

KEY:

- +crossshore = offshore, cm/sec
- crossshore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0805	45			57	19.4	1.0230	0.9
2	0808	110			73	20.3	1.0216	2.7
3	0940	115			49	20.3	1.0235	1.2
4	1001	50			35	20.0	1.0230	1.5
5	0748	105			55	20.6	1.0232	1.5
6	0737	50			98	19.7	1.0238	0.6
7	0645	100	60		105	20.0	1.0236	1.2
8	0815	115			191	20.0	1.0229	0.9
9	0920	115			61	20.3	1.0230	0.6
10	0852	105			71	20.6	1.0238	1.2
11	0715	45		Gauge	396	18.3	1.0224	0.9
12	0745	80			126	18.3	1.0222	0.6
13	0801	50			63	18.3	1.0224	0.9
14	0805	50			51	18.1	1.0224	1.8
15	0810	50			72	18.1	1.0230	0.6
16	1000	95	45		75	18.3	1.0226	0.6
17	1015	95			296	18.3	1.0222	0.6
18	0825	60		Inoperative	19	18.6	1.0221	0.9
19	0835	90			11	18.6	1.0218	1.5
20	0635	90			32	18.9	1.0214	1.8
21	0637	105			4	18.6	1.0222	1.5
22	0642	45			43	18.6	1.0238	0.6
23	0844	50			85	17.8	1.0232	1.2
24	0719	65	90		49	17.5	1.0234	2.4
25	0645	80	55		24	17.5	1.0232	1.8
26	0700	85	20		64	17.8	1.0224	2.1
27	0710	35			122	17.8	1.0208	0.6
28	0802	55			80	17.8	1.0212	0.3
29	0705	60			24	17.5	1.0212	0.9
30	0800	75			3	18.1	1.0230	0.6
31	0800	95			3	18.1	1.0230	1.8

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gauge is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

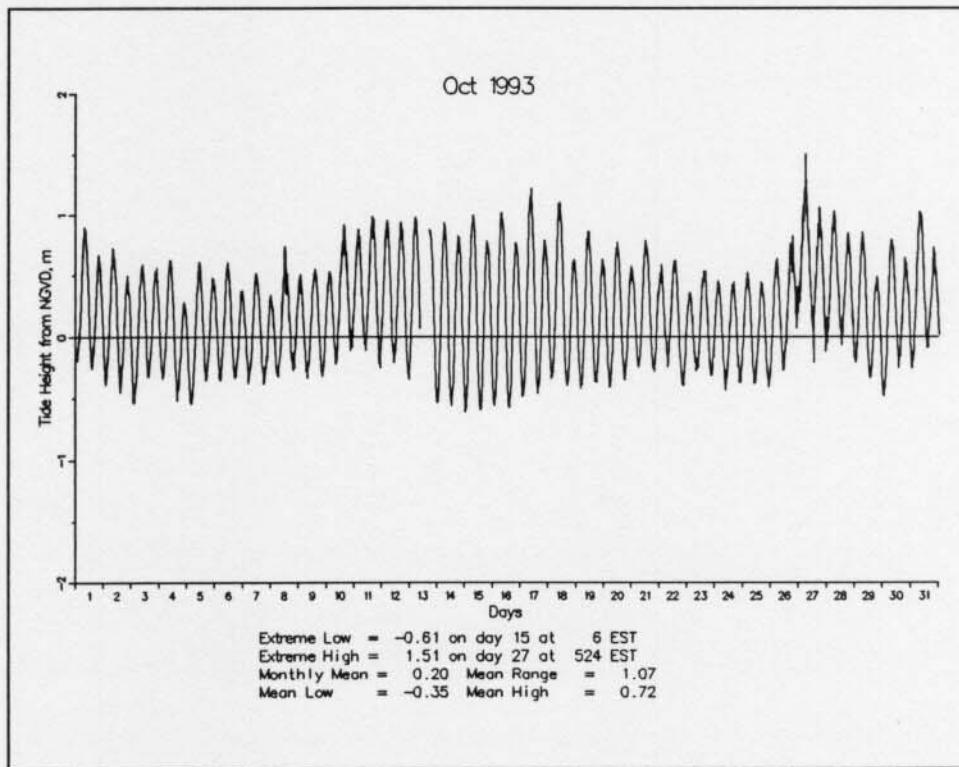


Figure 6. Water Level Time History

Table 8
Water Levels, m NGVD

October 93																
Day	High			Low			Mean	Range	High			Low			Mean	Range
	Time	m	Day	Time	m	m	m	m	Day	Time	m	Day	Time	m	m	
1	0712	0.90	1	0054	-0.20	0.34	1.09		16	1924	0.77	16	1412	-0.58	0.11	1.34
1	1906	0.67	2	0048	-0.35	0.16	1.02		17	0848	1.22	17	0106	-0.49	0.37	1.71
2	0718	0.73	2	0106	-0.39	0.18	1.11		17	2036	0.79	17	1436	-0.46	0.18	1.25
2	1954	0.49	3	0136	-0.54	0.00	1.03		18	0930	1.11	18	0224	-0.34	0.39	1.45
3	0912	0.59	3	0154	-0.54	0.07	1.12		18	2118	0.62	18	1612	-0.40	0.11	1.02
3	2118	0.56	4	0230	-0.33	0.10	0.90		19	1030	0.86	19	0330	-0.42	0.23	1.29
4	0848	0.63	4	1454	-0.43	0.13	1.05		19	2218	0.63	19	1712	-0.37	0.12	1.00
4	2036	0.28	5	0312	-0.55	-0.12	0.83		20	1124	0.77	20	0424	-0.41	0.19	1.18
5	1018	0.61	5	0324	-0.54	0.08	1.15		20	2324	0.58	20	1742	-0.35	0.12	0.93
5	2118	0.48	5	1612	-0.35	0.06	0.83		21	1136	0.79	21	0524	-0.25	0.28	1.04
6	1018	0.60	6	0430	-0.36	0.13	0.96		22	0136	0.59	21	1900	-0.29	0.14	0.87
6	2254	0.38	7	0406	-0.38	0.00	0.76		22	1212	0.62	22	0706	-0.25	0.21	0.87
7	1100	0.52	7	1718	-0.33	0.10	0.84		23	0154	0.36	22	2030	-0.40	-0.01	0.77
7	2348	0.34	7	1742	-0.38	-0.03	0.73		23	1406	0.54	23	0712	-0.28	0.13	0.82
8	1136	0.74	8	0600	-0.33	0.18	1.07		24	0224	0.45	23	2012	-0.31	0.06	0.77
9	0048	0.51	9	0612	-0.28	0.10	0.79		24	1548	0.45	24	0900	-0.44	0.03	0.88
9	1348	0.55	9	0700	-0.34	0.14	0.89		25	0330	0.53	24	2148	-0.37	0.08	0.90
10	0206	0.53	9	1954	-0.32	0.12	0.85		25	1512	0.45	25	0924	-0.38	0.01	0.83
10	1454	0.92	10	0742	-0.22	0.40	1.14		26	0448	0.63	25	2154	-0.41	0.13	1.05
11	0254	0.88	10	2012	-0.11	0.38	1.00		26	1812	0.82	26	1012	-0.27	0.27	1.10
11	1500	0.99	11	2042	-0.18	0.45	1.16		27	0524	1.51	26	2142	0.06	0.71	1.44
12	0412	0.95	11	2218	-0.25	0.37	1.21		27	1712	1.07	27	1230	-0.21	0.50	1.28
12	1548	0.94	12	2136	-0.22	0.35	1.16		28	0554	1.03	27	2236	-0.12	0.49	1.16
12	2140	No data for this tide cycle							28	1754	0.84	28	1230	-0.07	0.37	0.92
13	1005	No data for this tide cycle							29	0600	0.85	29	0018	-0.21	0.29	1.06
14	0548	0.94	13	2342	-0.54	0.19	1.47		29	1818	0.48	29	2330	-0.41	0.04	0.90
14	1754	0.83	14	1218	-0.56	0.14	1.39		30	0742	0.79	30	0024	-0.48	0.22	1.28
15	0642	0.99	15	0006	-0.61	0.24	1.61		30	1842	0.64	30	1318	-0.25	0.19	0.90
15	1848	0.78	15	1330	-0.59	0.10	1.38		31	0712	1.03	31	0054	-0.26	0.45	1.29
16	0654	1.01	16	0112	-0.56	0.25	1.58		31	1912	0.73	31	1336	-0.09	0.30	0.82

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in September 1993 and the survey(s) in October 1993 on profile line 188, located 517 m south of the pier.

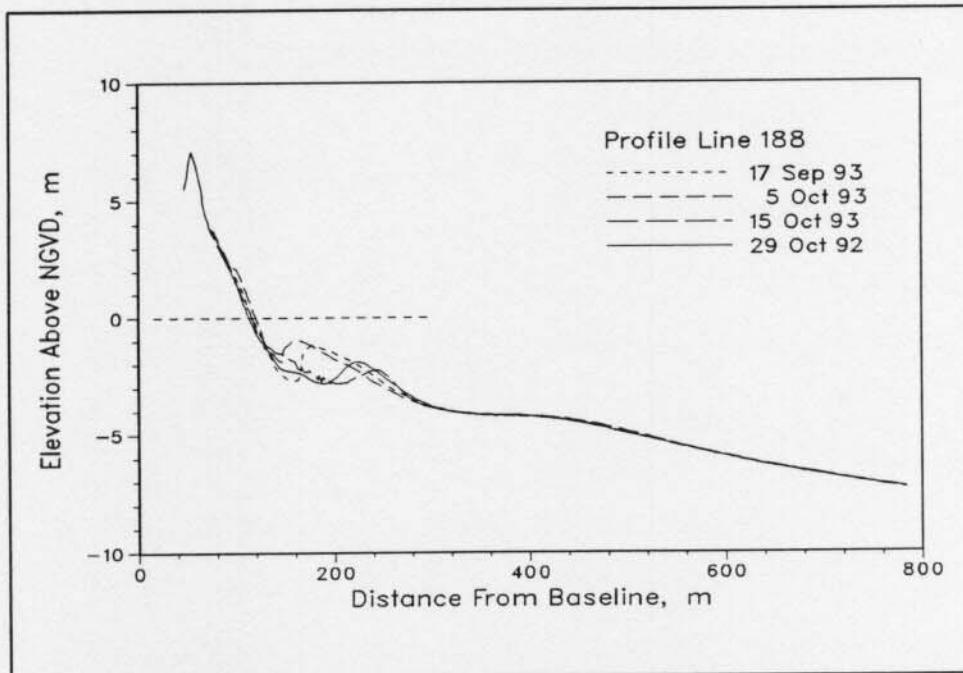


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1993. Cross-hatched areas indicate changes to the annual envelope which occurred in October.

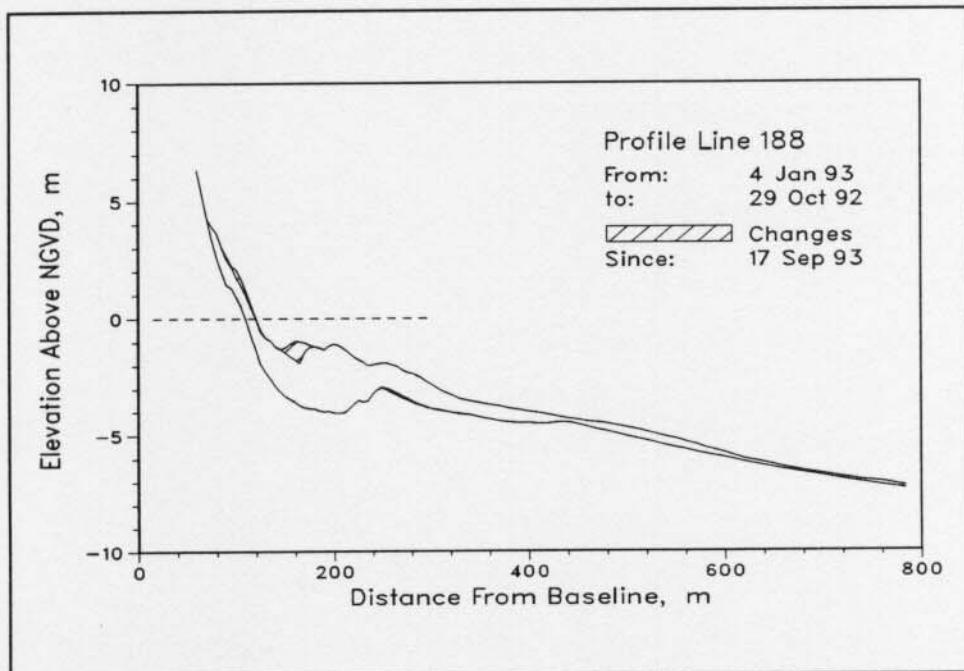


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 15 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

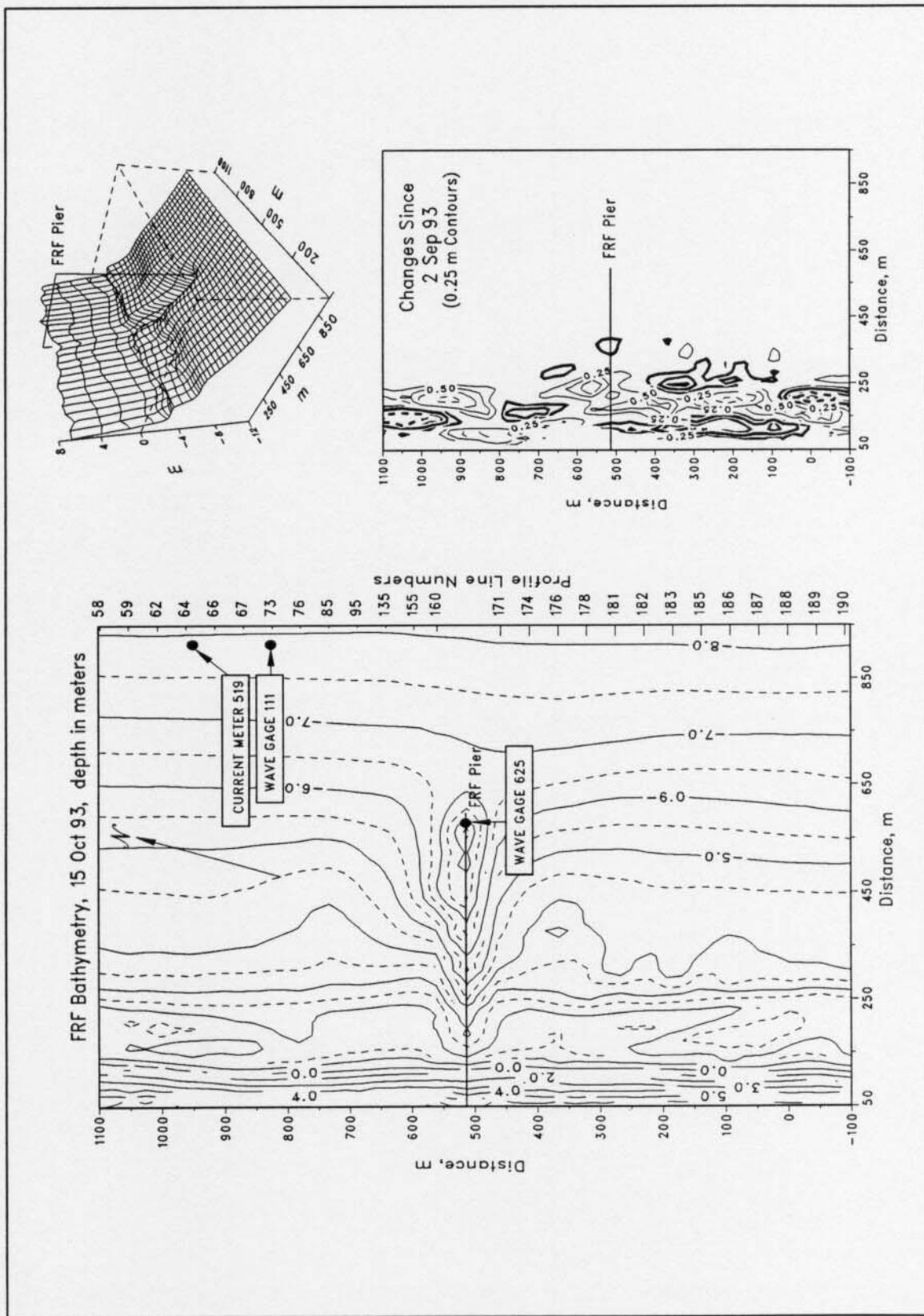


Figure 9. FRF Bathymetry, Depths Relative to NGVD

8 Special Events

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m.

<u>Start</u>	<u>End</u>
10 Oct (1334)	11 Oct (2342)
26 Oct (1408)	27 Oct (1634)

B. Storm Synopsis.

10-11 Oct Northeasterly winds were funneled between a high pressure system over New York and a low pressure system offshore of South Carolina. The maximum H_{mo} , at gauge 625, reached 2.38 m ($T_p=8.8$ s) at 1816 on 11 October. Maximum onshore winds reached 15 m/s at 1334 on 10 October. There was no precipitation.

26-27 Oct This low pressure system developed off the Florida Atlantic coast on the morning of 25 October. The storm had moved to the NW and was off the South Carolina coast by 26 October. By the morning of the 27th the storm was well out to sea off the coast of Virginia. The maximum H_{mo} , at gauge 630, reached 4.73 m ($T_p=10.7$ s) at 0016 on 27 October. Maximum onshore winds reached 23 m/s at 0134 on 27 October. There was 41 mm of precipitation.

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

Colleges/Universities:

Bucknell University	Scripps Institution of Oceanography
California Inst. of Tech.	Stockton State College
Duke Marine Lab	University Calif-Berkeley
East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
M.I.T.	University of Maryland-Baltimore
Naval Post Graduate School	University of North Carolina
NC State University	University of N C-Seagrant Program
Old Dominion University	University of Virginia
Oregon State University	Va. Inst. of Marine Science
Prince George's College	Rutgers University

Others:

Allied Signal Aerospace Co.	WCTI-TV
Applied Physics Lab	MEC Systems Corporation
Cape Hatteras Nat. Seashore	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	N.C. Div. Coastal Management
Coastal Science & Eng., Inc.	Oregon Inlet & Waterways Commis.
Dr. Cy Galvin	Raleigh-Durham Airport
GEOMET Tech., Inc.	Mr. Rowland
Mr. Hodges	Mr. Savage
Dr. Hylton	Science Application Int'l. Corp
Mr. Mason	Sherwood Industries
Mr. Rodgers	SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)